Similarities Across Mars: Acidic Fluids at Both Meridiani Planum and Gale Crater in the Formation of Magnesium-Nickel Sulfates

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Abstract Text:

In-situ identification of sulfates at the martian surface by the Mars Exploration Rovers and the Mars Science Laboratory have included calcium sulfates with various states of hydration (gypsum, bassanite, anhydrite), iron sulfates of likely fumarolic origin, massive deposits of iron hydroxysulfates indicative of an acidic history, and minor occurrences of magnesium sulfates. Recent measurements by the Opportunity and Curiosity Alpha Particle X-ray Spectrometers (APXS) have indicated the presence of Ni-substituted Mg-sulfates at the Meridiani Planum and Gale Crater landing sites.

The Opportunity rover has traversed nearly 43 km and is currently exploring the impact breccias of the rim of Endeavour crater, near a location where signatures of aqueous alteration have been established from orbit. APXS analyses of subsurface materials excavated by a rover wheel show clear evidence for a Mg(Ni)-sulfate with Mg:Ni ~100:1 (molar). On the other side of the planet, Curiosity is continuing its climb up Mount Sharp after driving ~13 km since landing. Over the last 4 km of the traverse, there have been multiple chemical analyses of erosionally-resistant nodules and dendritic features in a finely laminated mudstone unit which also indicate Mg(Ni)-sulfate (Mg:Ni ~30:1, molar).

The geologic settings for the Endeavour rim and the Mount Sharp mudstones are clearly different, but similar formation conditions for these sulfates may be possible. Ni(2+) readily substitutes for Mg(2+) in a variety of geochemical processes due to their comparable ionic radii. The availability of soluble Ni at the time of Mg-sulfate precipitation suggests acidic solutions. The fluids responsible for alteration in the Endeavour rim and for the formation of nodules in Gale mudstones may have had similar chemical characteristics at the time the Mg-sulfates were formed.